Assessment of Risks to Human Health from Particulate Emissions from Aircraft and Strategies for Risk Mitigation in Relation to the International Civil Aviation Organization Standard

Principal Investigator: Nobuyuki TAKEGAWA
Institution: Tokyo Metropolitan University
1-1 Minami-Osawa, Hachioji, Tokyo 192-0397, JAPAN
Tel: +81-42-677-2532 / Fax: +81-42-677-2532
E-mail: takegawa@tmu.ac.jp
Cooperated by: National Institute for Environmental Studies, National Institute of Advanced Industrial Science and Technology, Hokkaido University

[Abstract]

Key Words: Aircraft emissions, Ultrafine particles, International Civil Aviation Organization, Numerical simulations, Aircraft engine tests, Health risk assessment

Civil aviation has grown rapidly as a result of global economic development. The International Civil Aviation Organization has authorized a new regulatory standard for the mass and number emissions of particles emitted from aircraft engines and also promoted the development of sustainable aviation fuels for reducing net carbon emissions. Although civil aviation traffic in 2020 and 2021 was greatly reduced due to the Covid-19 pandemic, the global passenger market started gradually recovering in 2022 and is predicted to return to 2019 levels in 2023-2027. Therefore, the environmental impacts of aircraft emissions will continue to be an important issue in the following decades.

The major objectives of this project were to assess the health risks of aircraft-related ultrafine particles (UFPs) around major airports in Japan and also to propose effective measures for mitigating such risks in future. We have built a new framework involving aircraft engine tests, ambient measurements, numerical simulations, and health risk assessments. Field observations of UFPs were conducted at an observation site located near the runway and taxiway of Kobe Airport. We successfully estimated the particle number emission indices for takeoff and taxiing from specific aircraft. Direct measurements of particle number size distributions and size-resolved chemical compositions behind jet engines were performed at SR-Technics in Switzerland. The results clearly demonstrated the evolution of UFPs originating from jet engine lubrication oil during the expansion of plumes, which was consistent with the findings that we obtained at Narita International Airport. We have newly developed an empirical function for predicting the health risks of UFPs by using the particle number concentration as an input parameter. Mortality rates related to aircraft emissions around Haneda, Narita International, and Fukuoka Airports were estimated by combining the empirical function with numerical simulations obtained from an Aviation Environmental Design Tool model. Based on future predictions of the health risks associated with new engine and fuel technologies, we have proposed possible measures for mitigating the risks, focusing on the reduction of UFPs originating from jet engine lubrication oil.

To summarize, we have successfully obtained new insights that improve our understanding of aircraft UFP emissions and related health risks around major airports. The project outcomes provide a firm scientific basis for assessing the future health risks of aircraft emissions and the possible co-benefits of mitigating carbon emissions and improving human health.

[References]

1) Takegawa, N., A. Nagasaki, A. Fushimi, Y. Fujitani, Y. Murashima, and H. Sakurai, Volatility of aircraft exhaust ultrafine particles inferred from field measurements at Narita International Airport, Atmos. Environ., 292, 119391, 2023 (IF: 5.755; May 1, 2023).